

Emergency Response Fire-Imaging UAS Missions over the Southern California Wildfire Disaster

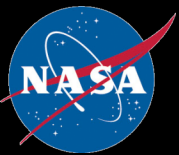


John Del Frate

NASA Dryden Flight Research Center

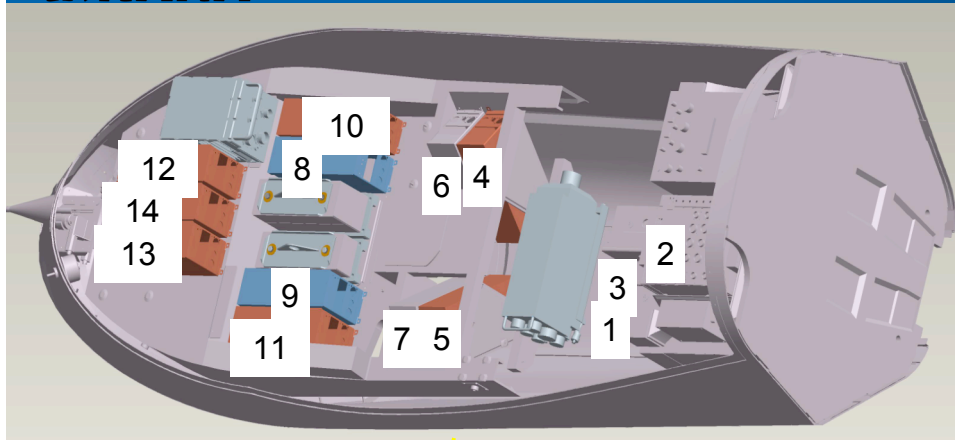
April 2008





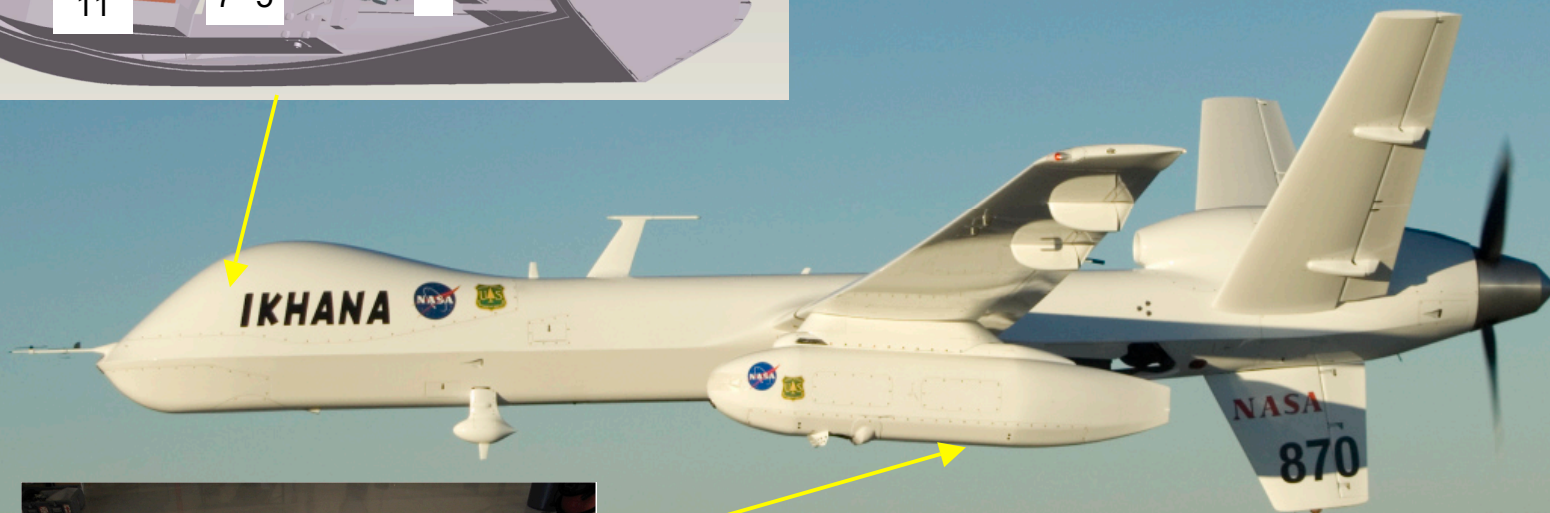
Western States Fire Mission Modifications

IKHANA



Back-up battery power increased to 3 hours

Wiring connections from pod to power distribution, GPS antenna, and SatCom system



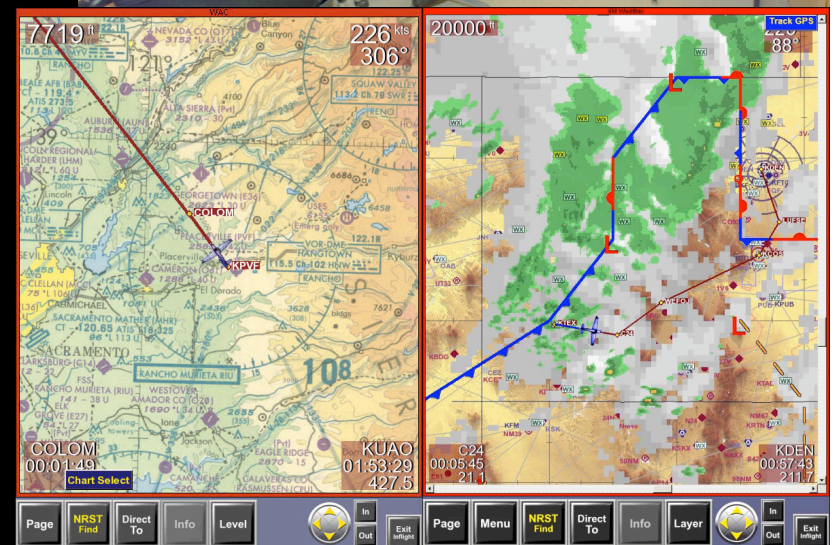
Infrared Wildfire Scanner



Ground Systems

IKHANA

- Mobile Ground Control Station
 - Dual pilot control station
 - Electronic navigation charts
 - Weather
 - 6 Engineering/Science workstations
 - Range safety workstation
 - Intercom system throughout
 - Overhead mission displays
 - Telephones
 - Remote video from aircraft start-up/shut-down site
 - Downlink video and data recording
- Mobile 2.4m Ku SatCom Antenna
 - Dual redundant receiver/transmitters





2007 Western States Fire Mission Objectives

IKHANA

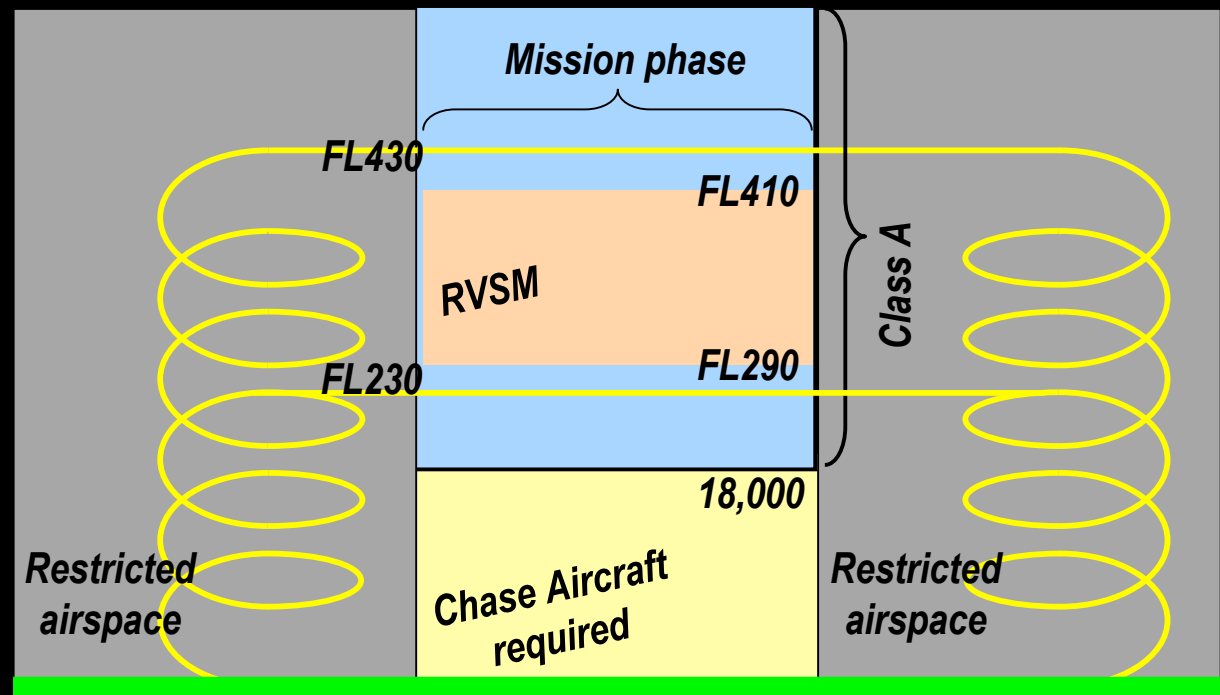
- Demonstrate capabilities of UAS to overfly and collect sensor data on widespread fires throughout Western US.
- Demonstrate long-endurance mission capabilities (20-hours+).
- Image multiple fires (greater than 4 fires per mission), to showcase extendable mission configuration and ability to either linger over key fires or station over disparate regional fires.
- Demonstrate new UAV-compatible, autonomous sensor for improved thermal characterization of fires.
- Provide automated, on-board, terrain and geo-rectified sensor imagery over OTH satcom links to national fire personnel and Incident commanders.
- Deliver real-time imagery (within 10-minutes of acquisition).
- Demonstrate capabilities of OTS technologies (GoogleEarth) to 'serve' and display mission-critical sensor data, coincident with other pertinent data elements to facilitate information processing (WX data, ground asset data, other satellite data, R/T video, flight track info, etc).

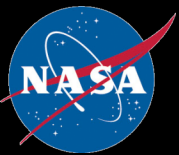


Operations Concept

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- Chase aircraft required below 18k in the U.S. National Airspace (NAS)
- Air traffic control (ATC) used for collision avoidance above 18,000 ft
- NASA Dryden uses restricted airspace to climb to cruise altitude before exiting into the NAS
- Since Ikhana not qualified for Reduced Vertical Separation Minima (RVSM), operations are limited to 18,000 ft to FL 290 or above FL 410
- Transponder and radio communication required





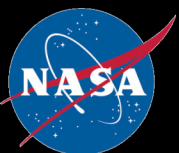
Certificate of Authorization (COA) Boundary Request

IKHANA

3 Operational Zones

Each zone includes no more than 3 ARTCC areas





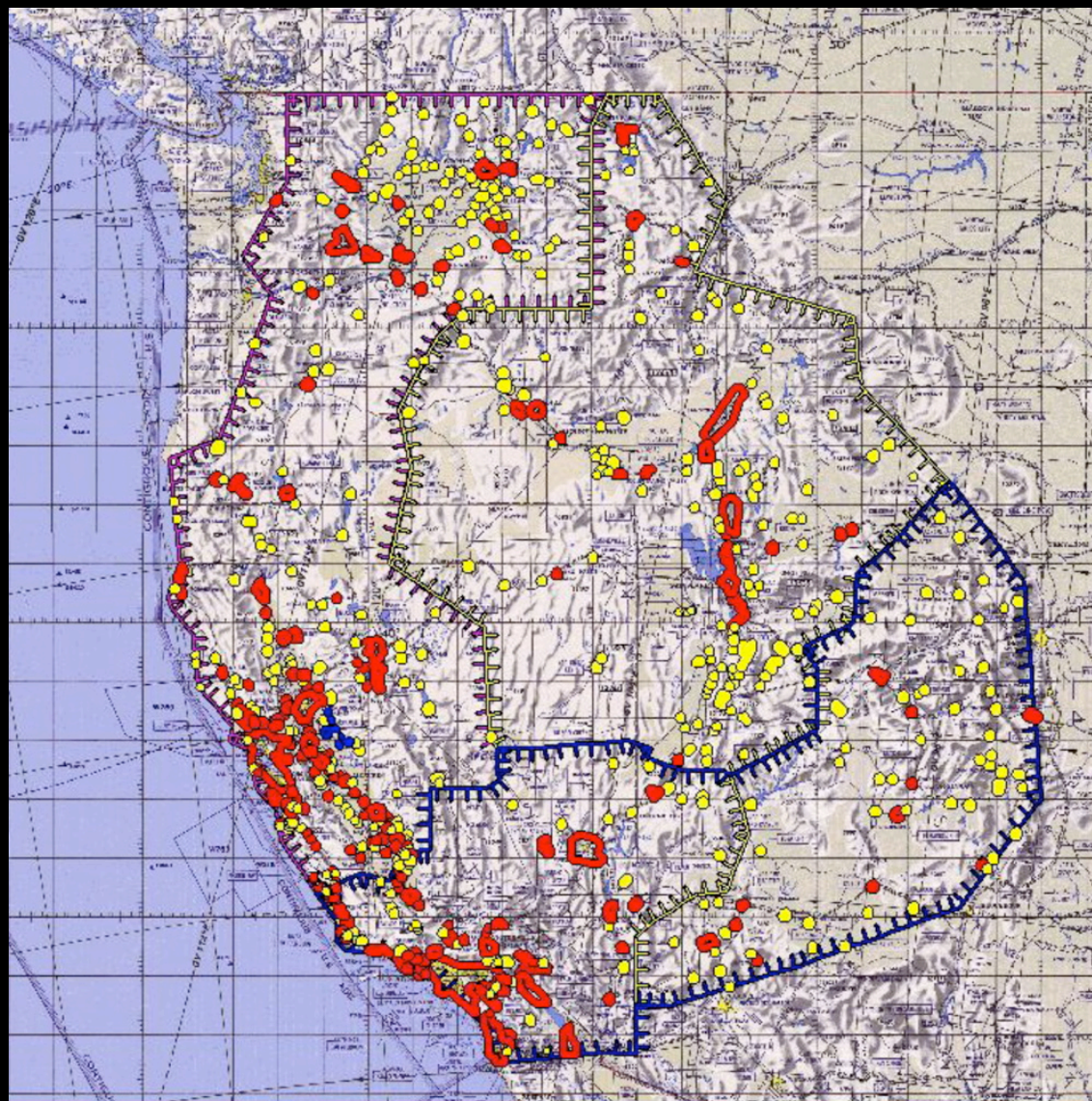


Range Safety Protection Zones

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KEEP-OUT
ZONES

-  NOMINAL
AIRCRAFT
-  UNHEALTHY
AIRCRAFT





Primary Emergency Landing Sites

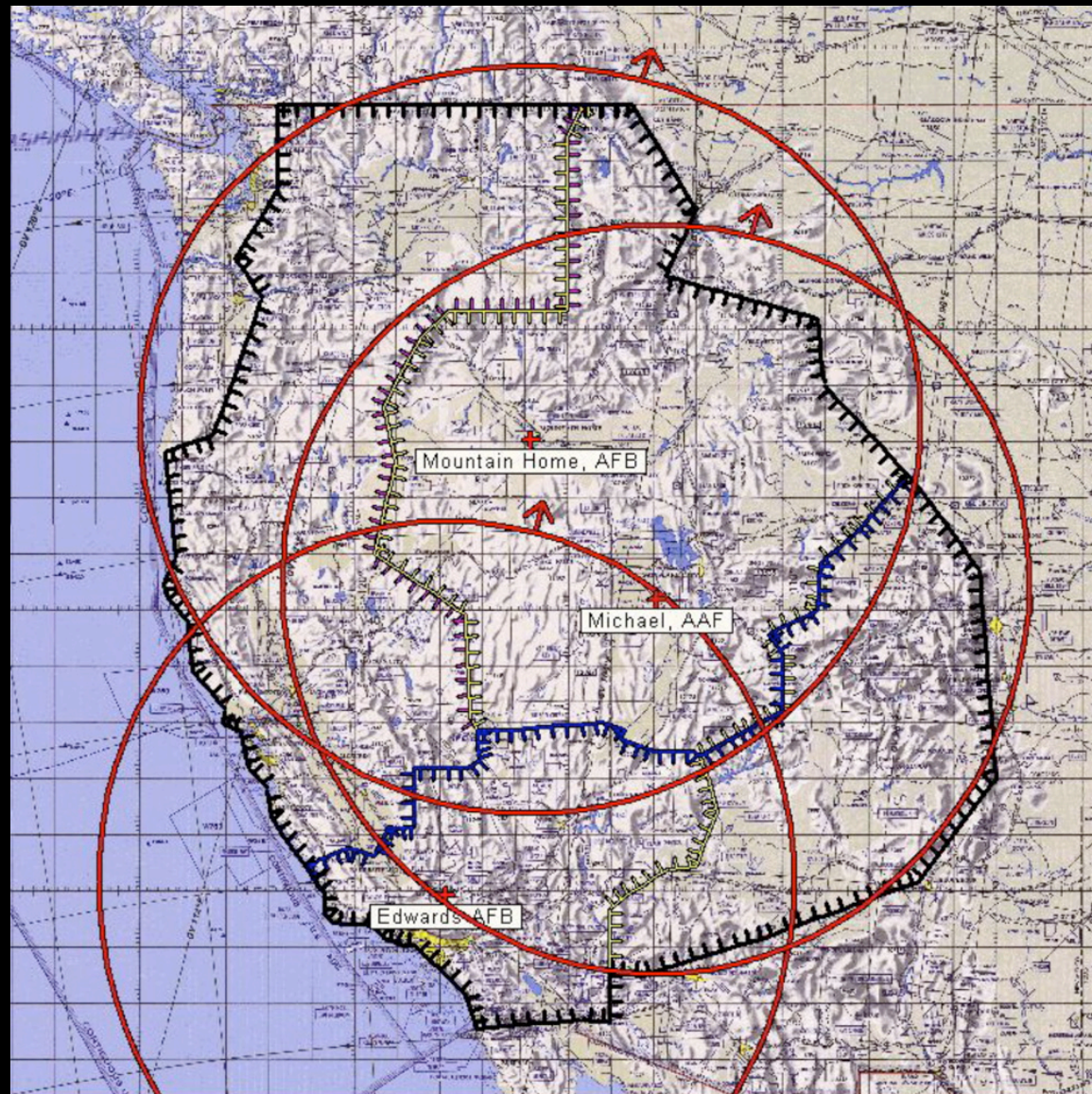
IKHANA

Radius =400 nmi

**Minimum Range
on Battery
Power**

**Aircraft has
single generator**

**Landing
agreements
negotiated with
each site**





Secondary Emergency Landing Sites

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Radius=50 nmi

**Minimum glide distance
from 23,000 ft**

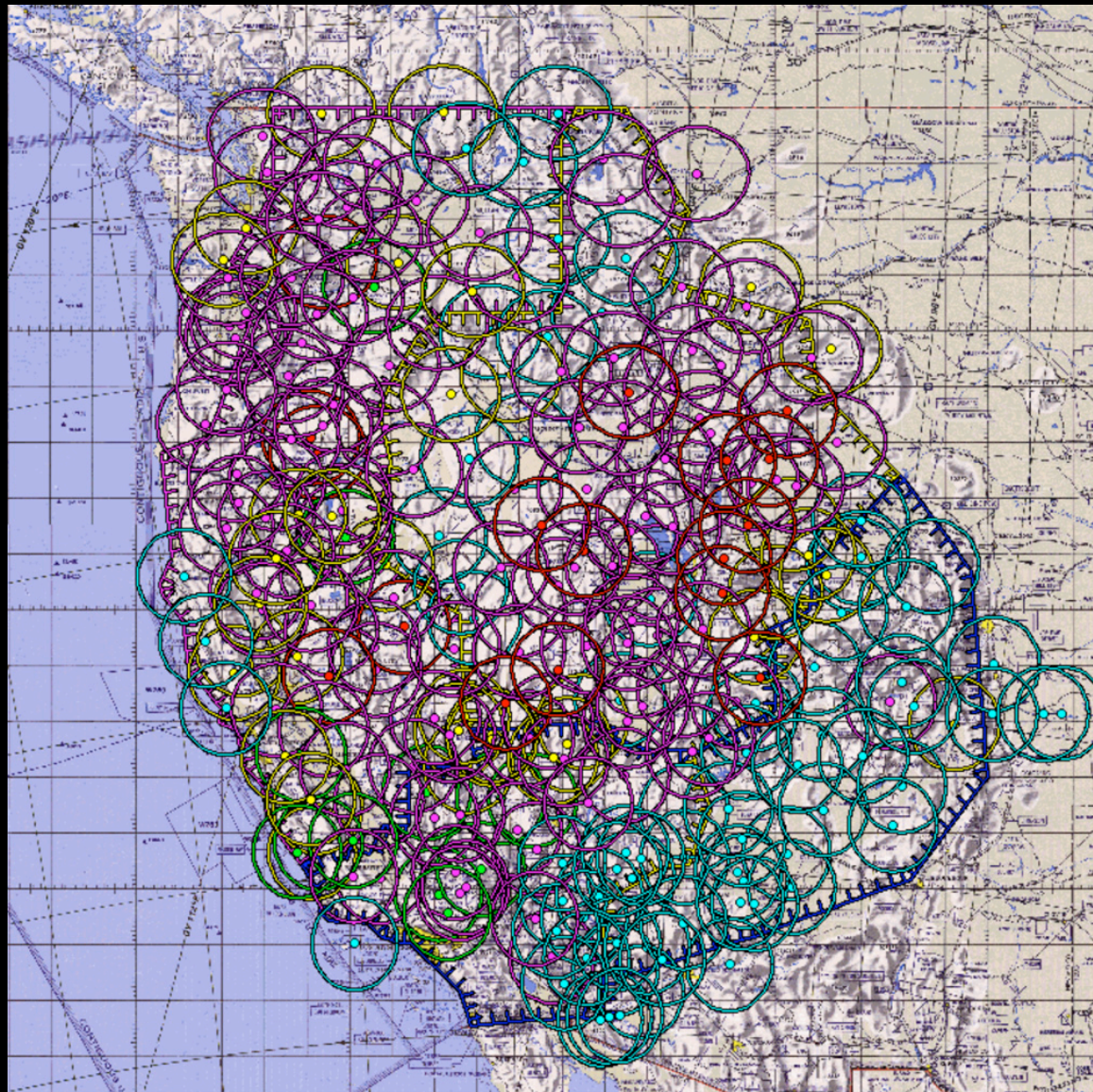
Over 280 sites identified

**Categorized Green, Yellow,
Purple, Red by pilots**

**Selected in unpopulated
areas. Abandoned runways,
dry lakebeds, flat ground,
ditch areas**

**Primary purpose is to
protect public**

**Actively managed during
each mission**



Example Secondary Emergency Landing Site

Mac Gillivray

Near **Adelaida, CA**

(Abandoned landing strip)

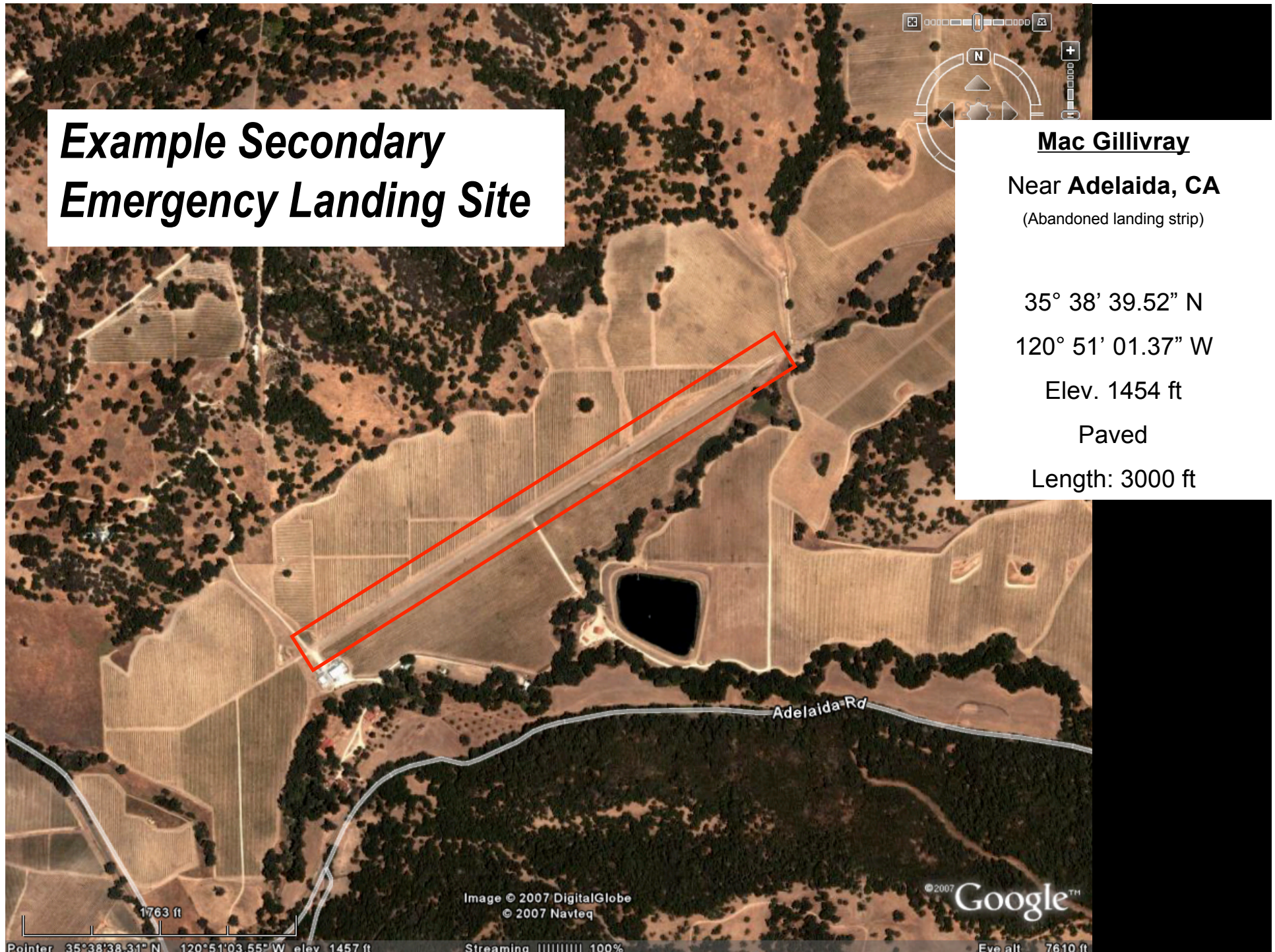
35° 38' 39.52" N

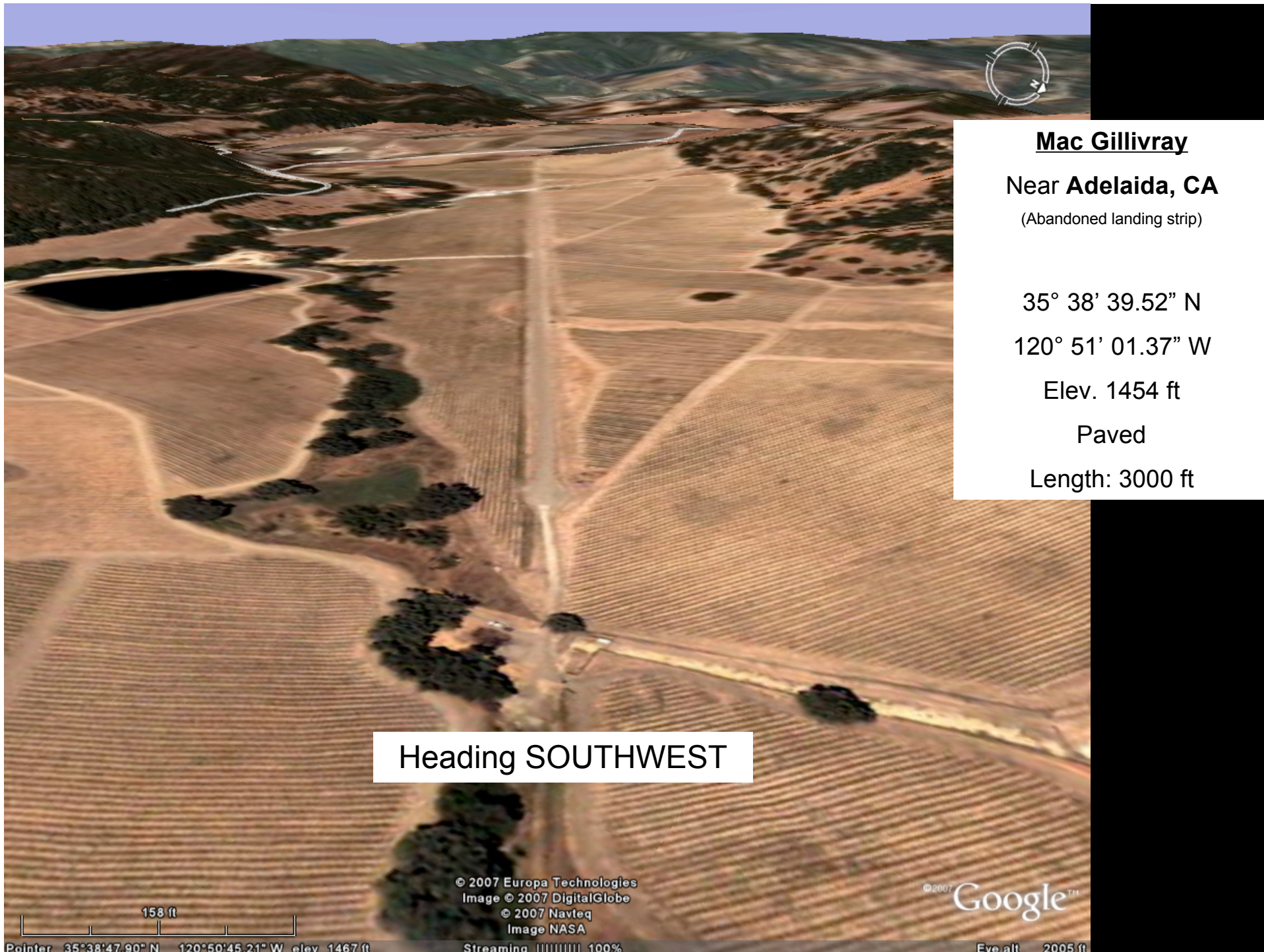
120° 51' 01.37" W

Elev. 1454 ft

Paved

Length: 3000 ft





Mac Gillivray

Near **Adelaida, CA**

(Abandoned landing strip)

35° 38' 39.52" N

120° 51' 01.37" W

Elev. 1454 ft

Paved

Length: 3000 ft

Heading SOUTHWEST

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Image NASA

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158 ft
Pointer 35°38'47.90" N 120°50'45.21" W elev. 1467 ft

Streaming 100%

Eve all 2005 ft

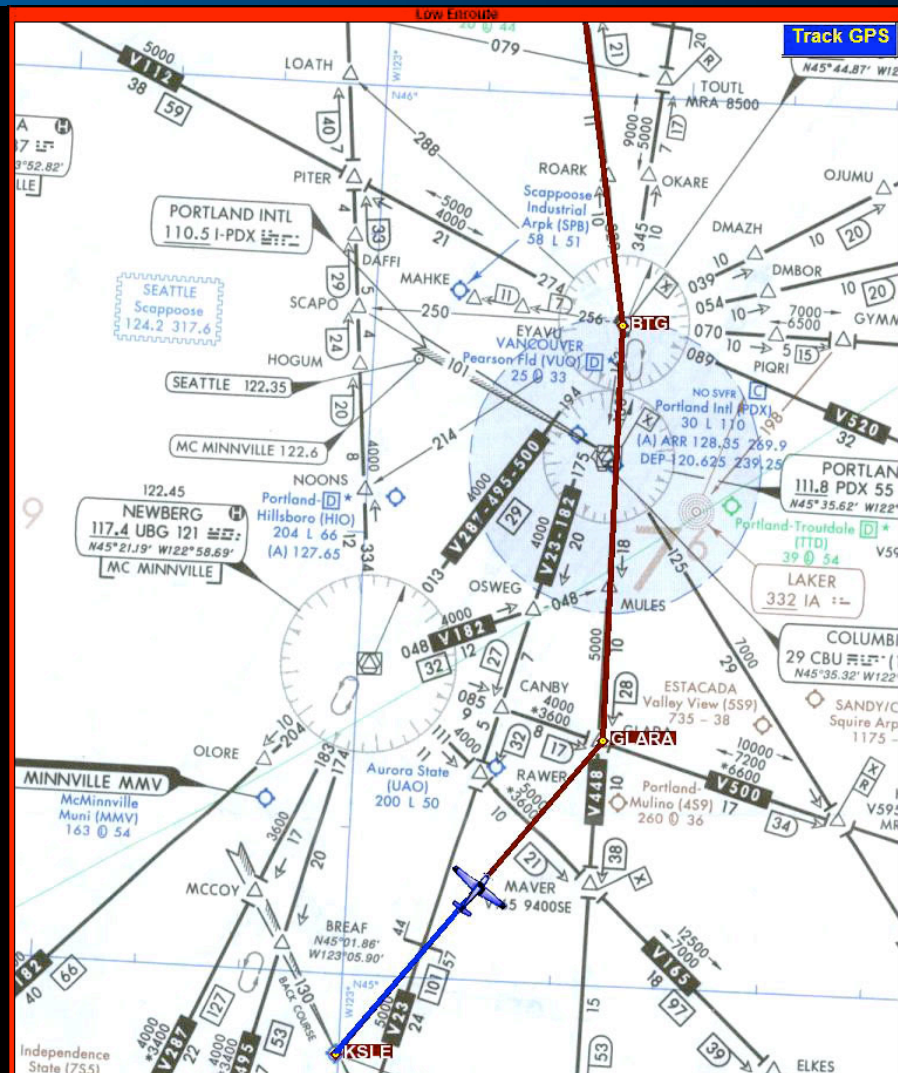


Chart Case Professional

IKHANA



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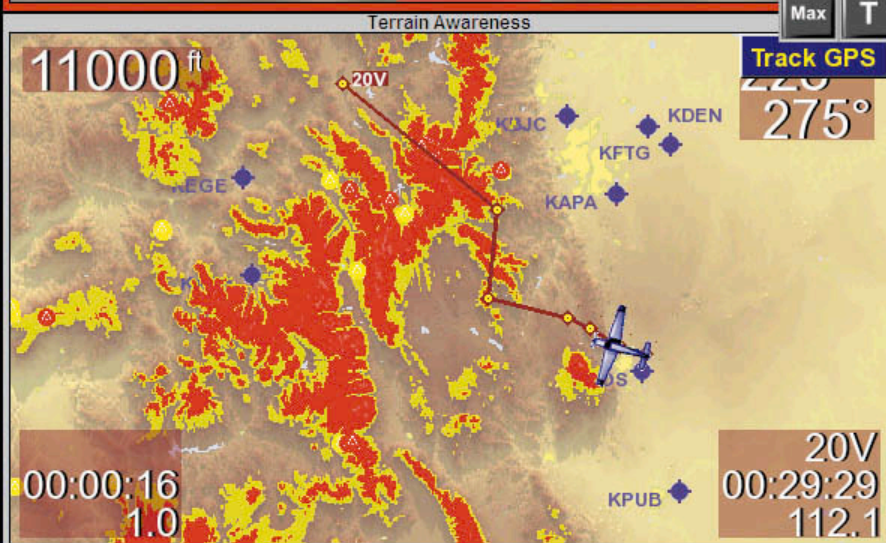
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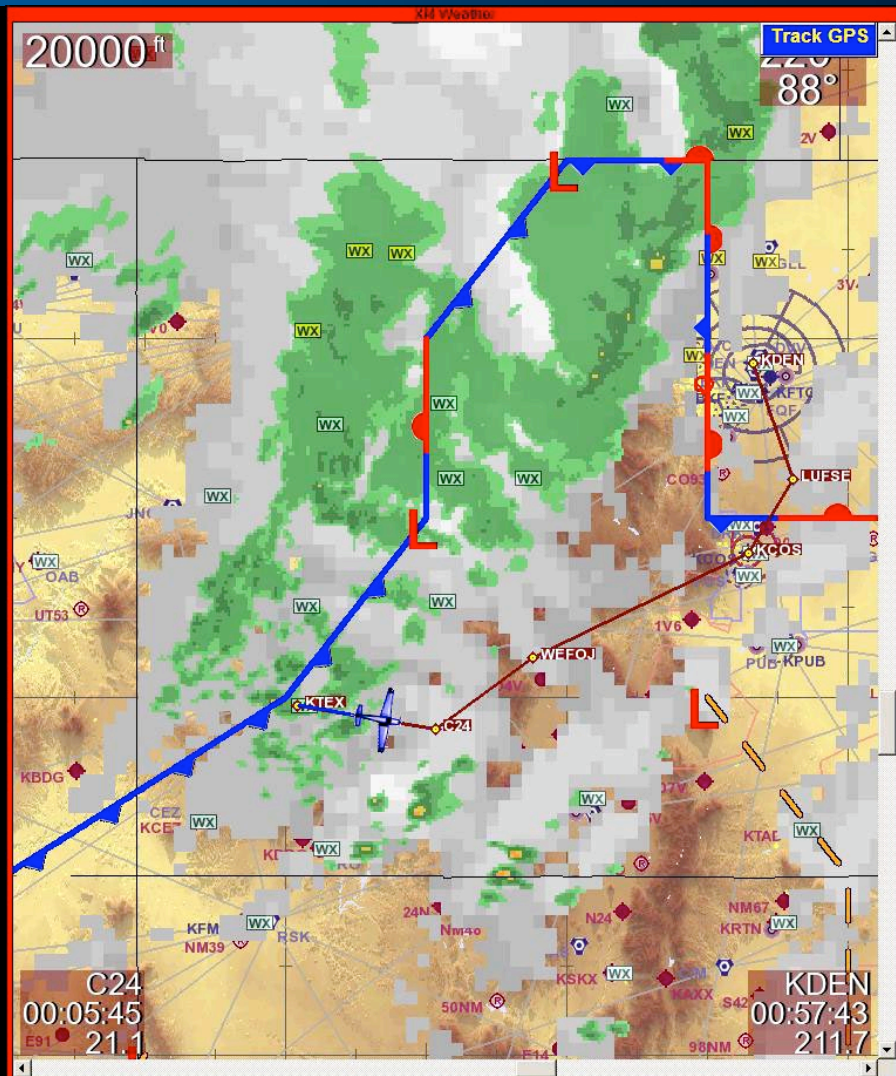
Chart Case Professional

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HITS - CAUTION - GPS Derived data, No Pitch or Bank Information - CAUTION - HITS



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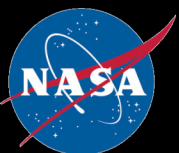
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COA: Special Provisions

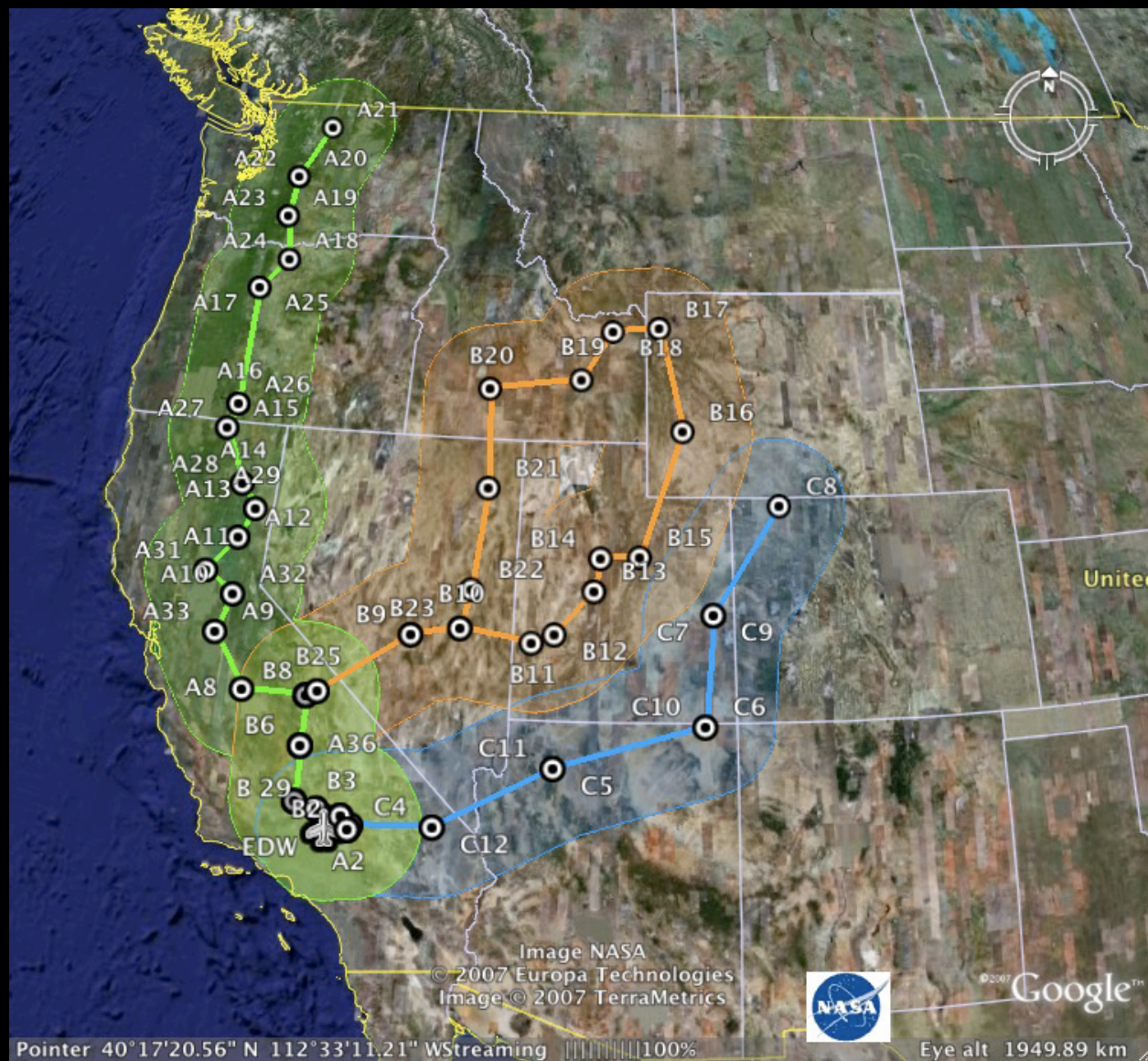
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- Remain within 75nm of 'backbone' route
- Point to point flight plan
- 3 business day mission notification to FAA
- No flight in to forecasted "moderate or severe" turbulence
- No flight in area where convective SIGMET has been issued
- No flight in area of known or forecast icing
- Lost link procedure: continue on route for 15 min
- No flight in area of affected by GPS testing, solar storms or RAIM outages



Approved COA Area

IKHANA



First 4 Fire Missions

1st Fire Mission 8/16/07
9.5 hours
1400 nmi

2nd Fire Mission 8/29/07
16.1 hours
2500 nmi

3rd Fire Mission 9/7/07
20 hours
3200 nmi

4th Fire Mission 9/27/07
10 hours
1800 nmi

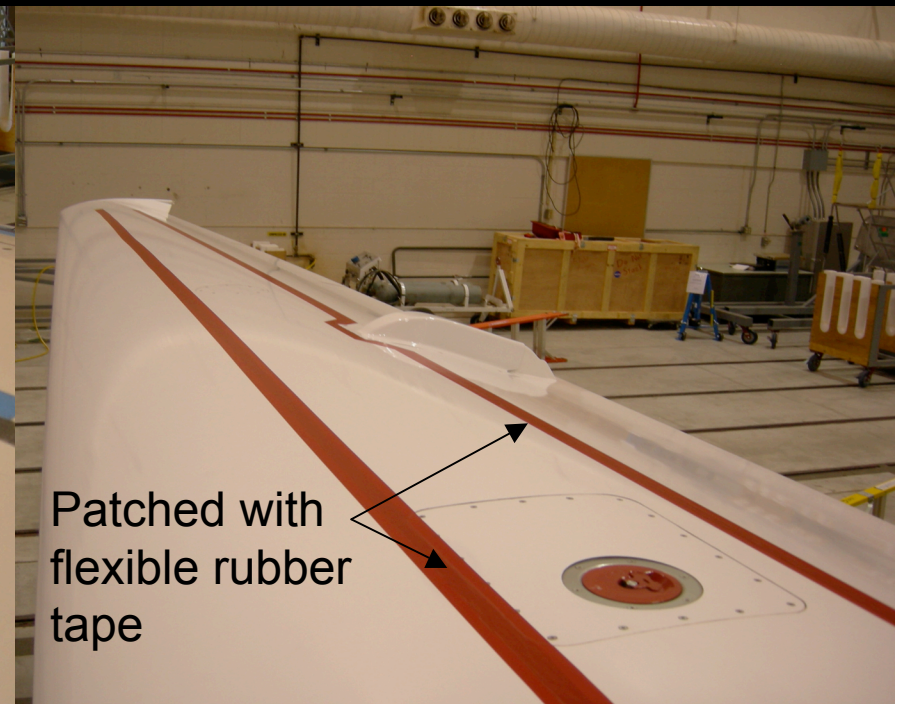
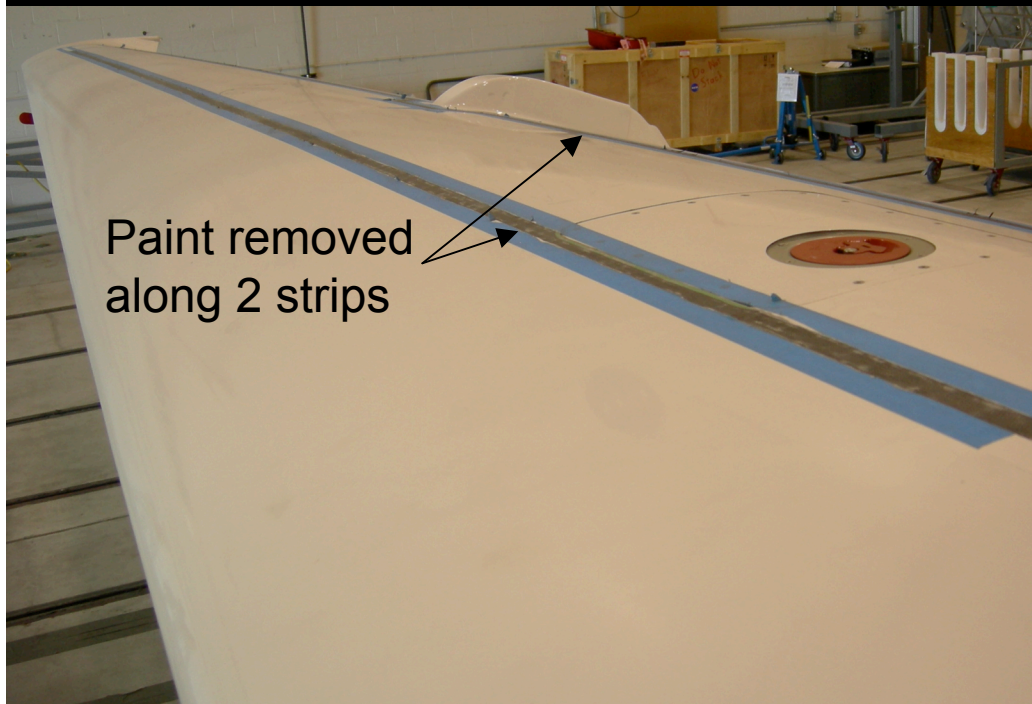




California Emergency Wildfire Response

IKHANA

- Oct 20-21: High winds >50 MPH drive wildfire in 4 southern California counties
- Oct 22nd: Ikhana team began preparation for a possible fire mission
- Two impediments to launching a mission
 - Failed hard drive in the wildfire sensor
 - Ikhana wings being modified for fiber-optic wing sensor demonstration
 - Tiger team assembled to assess airworthiness





California Emergency Wildfire Response

IKHANA

Oct 22nd

- Ikhana Project team contacted by California Office of Emergency Services requesting imagery of Southern California wildfires
 - Kim Zagaris, Chief Fire and Rescue Branch
 - 500,000 people evacuated
 - More than 11 fires burning
- Planning telecons held with NASA teams and USFS
- FAA notified
- Range safety office began reviewing population centers around fire areas
- NASA Ames and USFS teams deploy to Southern California
- Wing repair completed

Oct 23rd

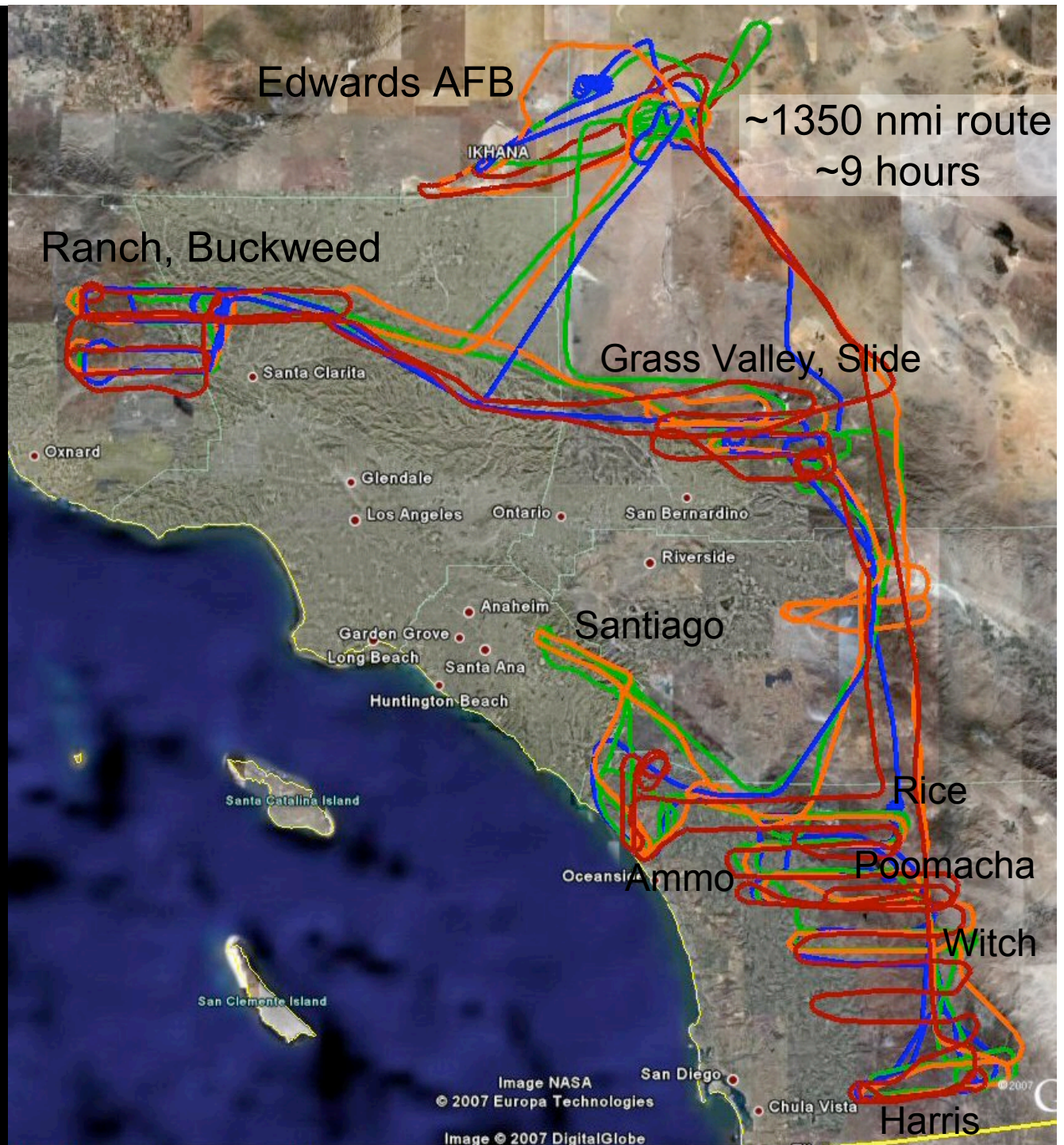
- Sensor hard drive repaired and verified
- FAA extended COA to within 10 mi of Mexican border within hours of request
- Mission plan submitted to FAA
- Tech Brief of mission plan delivered to NASA Dryden Management

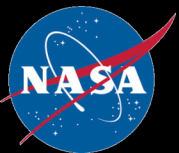
Oct 24th

- Launched 1st emergency response mission @ 9am



SoCal Emergency Response Missions





Ammo Fire, Oct 24th

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Hot spots in yellow

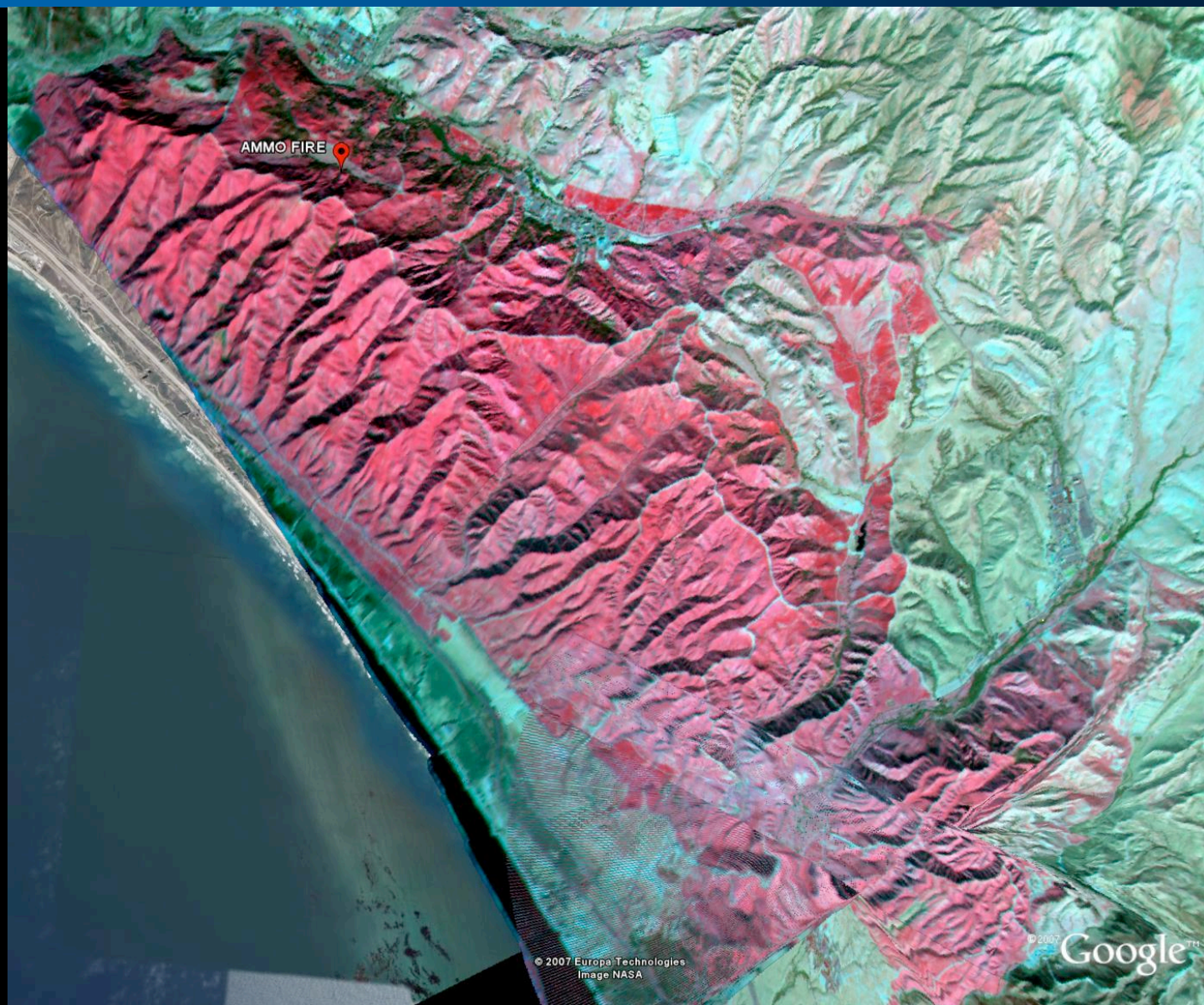




Ammo Burn Area, Oct 28th

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***Sensor optimized
for Burn Area
Emergency
Response (BAER)
imagery***





Santiago Fire, Oct 28th

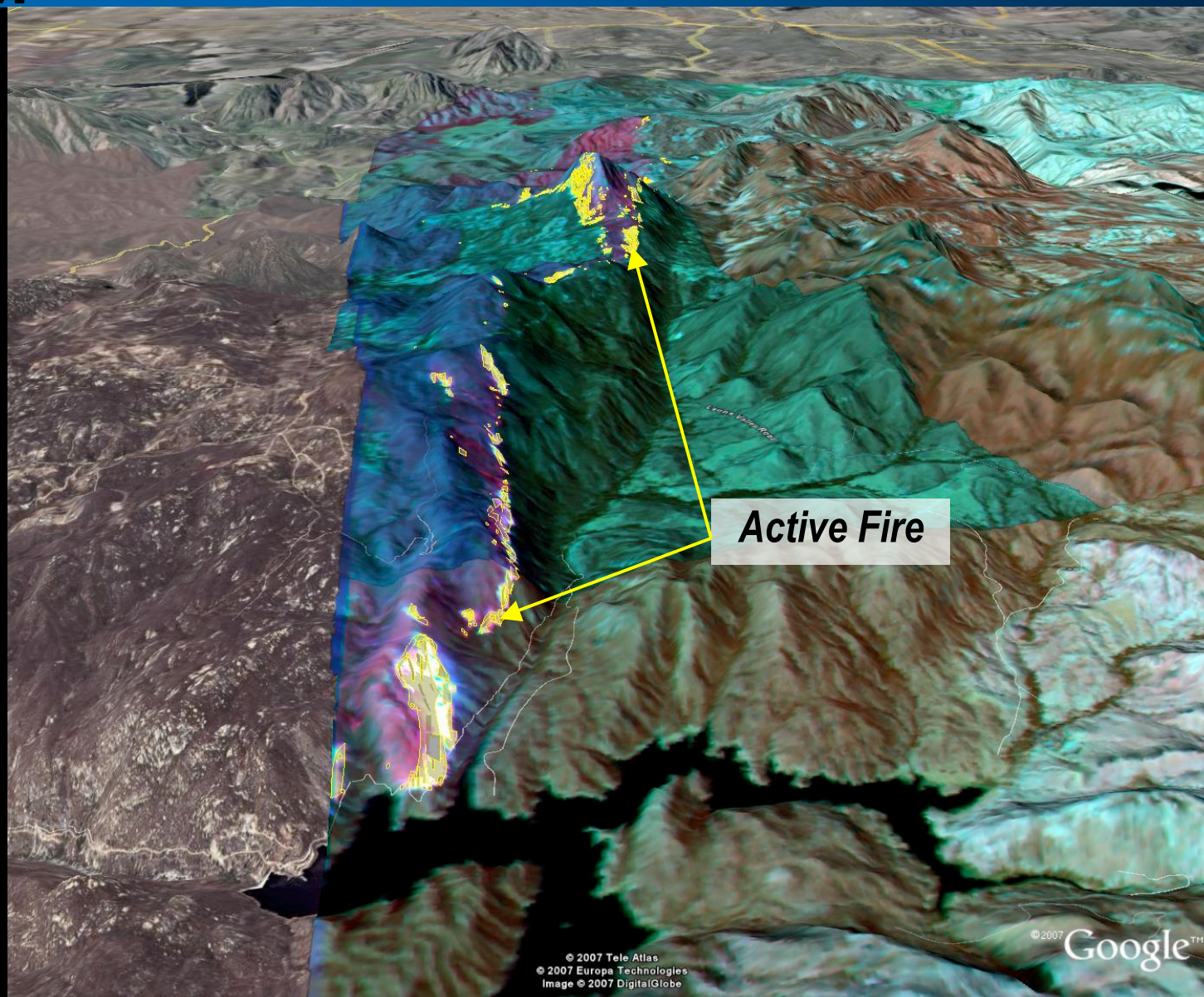
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Harris Fire, Oct 27th

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Mission Results

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- Four 9-hr missions flown over 5 day period
- Thermal infrared imagery delivered in near real-time (5 to 15 minutes) to:
 - Emergency ops: FEMA, NIFC, NorthCom, California EOC
 - Individual Fire Incident Commands
- Air Traffic Control gave excellent support
 - Mission plans flown in reverse
 - Real time requests for revisits of active fires
 - Added new fire during mission
 - Moved fire loiter points as fires moved
 - Earlier in summer, significant real-time reroute around thunderstorm activity
- Post Mission telecons with FAA were held to review mission and plan for next day
 - No issues with air traffic control during the 8 fire missions flown over the summer

Questions?

